PCT/IL96/00036

23 JULY 1996

STATE OF ISRAEL

זאת לתעודה כי
רצופים בזה העתקים
נכונים של המסמכים
שהופקדו לכתחילה
עם הבקשה לפטנט
לפי הפרטים הרשומים
בעמוד הראשון של
הנספח.

This is to certify that
annexed hereto is a true
copy of the documents as
originally deposited with
the patent application
particulars of which are
specified on the first page
of the annex.

This 5 -07- 1998 היום

רשם הפטנטים
Registrar of Patents

חוק הפטנטים, תשכ"ז - 1967
PATENTS LAW, 5727-1967

בקשה לפטנט
Application For Patent

לשימוש הלשכה
For Office Use

מספר: Number	114691
תאריך: Date	21-07-1995
הוקדם/נדחה Ante/Post-dated	

אני, (שם המבקש, מענו ולגבי גוף מאוגד - מקום התאגדותו)
I, (Name and address of applicant, and in case of body corporate-place of incorporation)

קדנט בע"מ, חברה ישראלית, מרחוב סחרוב 11, ראשון-לציון 75707, ישראל
CADENT LTD., Israeli Company, of 11 Saharov St., Rishon Le-Zion 75707, Israel

הממציא: אבי קופלמן
The Inventor: Avi Kopelman

בעל אמצאה מכח הדין
Owner, by virtue of Right of Law

ששמה הוא
of an invention the title of which is

(בעברית)
(Hebrew)

שיטה ומערכת לקבלה של דגם שיניים תלת-מימדי

(באנגלית)
(English)

Method and system for acquiring three-dimensional teeth image

מבקש בזאת כי ינתן לי עליה פטנט
hereby apply for a patent to be granted to me in respect thereof.

* בקשת חלוקה — Application of Division	* בקשת פטנט מוסף — Appl. for Patent of Addition	* דרישת דין קדימה Priority Claim		
מבקשת פטנט from application	* לבקשה/לפטנט to Patent/Appl.	מספר/סימן Number/Mark	תאריך Date	מדינת האיגוד Convention Country
מס' No.	מס' No.			
מיום dated	מיום dated			

* יפוי כח : P.O.A. :

עוד יוגש
תוגש בענין קודם filed on a previous case

המען למסירת מסמכים בישראל
Address for Service in Israel

DR. REINHOLD COHN AND PARTNERS
Patent Attorneys
P.O.B. 4060, Tel-Aviv
C. 98531

חתימת המבקש
Signature of Applicant

For the Applicants,
DR. REINHOLD COHN AND PARTNERS
By : –

היום 20 בחודש July שנת 1995
This 20 of July of the year 1995

לשימוש הלשכה
For Office Use

טופס זה כשהוא מוגש בחותם לשכת הפטנטים ומושלם בסמכר ובתאריך החגשה, הנו אישור להגשת הבקשה שפרטיה רשומים לעיל.
This form, impressed with the Seal of the Patent Office and indicating the number and date of filing, certifies the filing of the application the particulars of which are set out above.

* מחק את המיותר

שיטה ומערכת לקבלה של דגם שיניים תלת-מימדי

Method and system for acquiring three-dimensional teeth image

CADENT LTD.

קדנט בע"מ

The inventor:
Avi Kopelman

הממציא:
אבי קופלמן

C. 98531

METHOD AND SYSTEM FOR ACQUIRING THREE-DIMENSIONAL TEETH IMAGE

FIELD AND BACKGROUND OF THE INVENTION

The invention is generally in the field of dentistry and concerns a method and system for acquiring a three-dimensional image of teeth geometry. In the following, the term "dental image" will be used to denote an acquired three-dimensional teeth image.

The term "partial dental image" will be used to denote an image of part of the teeth surface, e.g. an image of only the lingual surfaces of the teeth ("lingual image") or of only the buccal surfaces of the teeth ("buccal image"); the term "sectional dental image" will be used to denote an image of a section of the teeth, i.e. not including all the teeth.

The obtaining of a dental image is highly important for various dental, and particularly orthodontic procedures. The dental image is required in order to make treatment decisions, e.g. design braces or the like, and to allow a follow-up of an orthodontal treatment. Typically, in accordance with existing methods, a teeth impression in an appropriate matrix is obtained and from that a positive, typically plaster, teeth model is prepared. Such a teeth model can be stored as such, can be photographed, can be scanned and stored digitally in a computer, etc. Scanning and digitizing a three-dimensional teeth image is a relatively complex procedure. Various methods have been proposed which involves direct scanning of teeth by probes which forms part of an imaging system fixed to the skull, but this procedure is and cannot be easily practiced in widespread use.

GENERAL DESCRIPTION OF THE INVENTION

It is an object of the invention to provide a novel method for acquiring a dental image.

It is another object of the invention to provide a system for acquiring a dental image.

It is furthermore an object of the invention to provide a tool for obtaining a teeth impression useful in the above method and system.

In accordance with the first of its aspects, the present invention provides a method for obtaining a dental image, being a three-dimensional teeth image. Several embodiments of the method are provided. In accordance with a first embodiment, the method comprises:

(a) immersing the teeth, wholly or partially, in an immersion matrix which is *a priori* soft and which is curable within a time period so as to obtain a teeth impression, having a top face corresponding in the directions of the teeth base and a bottom face corresponding to a teeth apex, and having a plurality of cavities or recesses, the boundaries of which correspond to boundaries of the teeth;

(b) removing a layer off a face of choice which is either the upper or the bottom face of the teeth impression so as to obtain a flat, horizontal surface, and acquiring a first elevational, two-dimensional image of the flat surface;

(c) removing a layer off the chosen face so as to obtain a new flat surface and acquire a consecutive elevational two-dimensional image of the new flat surface;

(d) repeating step (c) a plurality of times until removal of all layers of the teeth impression;

(e) determining boundaries of the cavities or recesses in the first image and in each of the consecutive images to obtain a plurality of boundaries representations of the first and subsequent images;

(f) combining all boundaries' representations into a three-dimensional dental image.

Although the above described embodiment is preferred in accordance with the invention, it is possible also to perform the present invention in accordance with an alternative embodiment. In this alternative embodiment, the teeth impression is utilized to obtain a three-dimensional teeth model, by filling the teeth impression with an appropriate plaster and allowing it to cure. Then the model is processed in a similar manner to that described above, namely levelling the chosen surface to obtain a flat, horizontal surface, acquiring a first elevational image of the surface, then removing subsequent layers and acquiring subsequent images, determining the teeth contours from each of the acquired images and then combining all determined contours into a three-dimensional teeth image.

In accordance with a third embodiment of the invention, rather than acquiring planar images of either the teeth impression or the teeth model, the slices are carefully removed and an image of the slices is then acquired.

The image acquired by the system may be a complete dental image or may be a partial dental image including a lingual image or a buccal image. Furthermore, the image acquired may also be a sectional dental image, it may be an image of all teeth of the section in their entirety, or only a partial dental image.

It should be noted that in order to obtain an accurate dental image, the layers removed in each step should be relatively thin, e.g. about 0.05 - 0.2 mm.

As will be appreciated, step (e) in the above process, which is the step of boundary determination, can be performed either at essentially real time immediately after image acquisition or can be performed at a later time after acquiring all of the images.

In accordance with a preferred embodiment of the method of the invention, the walls of the cavities or recesses are colored to facilitate the obtaining of clear boundaries. Where the teeth impression consists of cavities, these can be filled by a dye with a contrasting color to allow easy boundary determination.

In accordance with another aspect of the present invention, there is provided a system for obtaining a dental image. The system comprises:

(a) a fastener for holding a matrix comprising either a negative teeth impression or a positive teeth model;

(b) a cutting tool for removing successive thin slices of the matrix;

(c) an imaging device for acquiring successive two–dimensional elevational images of either said matrix or of slices removed therefrom, and digitizing the acquired images;

(d) a processor for combining a plurality of successive digitized acquired images into a three–dimensional dental image.

In accordance with the present invention, use is preferably made with a novel tool for obtaining a teeth impression and for holding the matrix containing the teeth impression while slices are removed therefrom in said system. While the use of this tool within the framework of the above methods and system is a preferred embodiment of the methods and system, it also forms an independent aspect of the present invention. This tool comprises a base; and a matrix retainer fixed on to the base and having a recess for holding an impression matrix, the recess having a general shape allowing immersion of teeth or portions thereof in the impression matrix, to form a negative teeth impression in the matrix, said member being made of a substance which can be cut by a cutting tool capable of cutting the matrix.

The matrix retainer may be designed to allow obtaining of a complete teeth impression. It is also possible to design the matrix retainer to obtain a partial teeth impression, e.g. an impression of only the lingual

or only the buccal surfaces of the teeth. Furthermore, the matrix retainer may also be designed to obtain only a sectional dental impression.

In accordance with an embodiment of the invention, the base holds two matrix retainers, fixed on opposite sides thereof, for simultaneously obtaining of a dental image of teeth of both the upper and the lower jaws.

In the following, the invention will be illustrated with reference to some specific, non-limiting embodiments, with occasional reference to the annexed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is an isometric view of a tool in accordance with an embodiment of the invention, for obtaining a full impression of the teeth of either the upper or lower jaw;

Fig. 2 shows the tool of Fig. 1 containing an impression matrix with a teeth impression fixed therein;

Fig. 3 is a plan view of the tool of Fig. 2;

Fig. 4 is a schematic representation of the manner of slicing off layers from the block carried on the tool of Fig. 2;

Fig. 5 shows the acquired teeth contours;

Fig. 6 is an isometric view of a tool in accordance with an embodiment of the invention for obtaining an impression of lingual teeth parts;

Fig. 7 is an isometric view of a tool in accordance with an embodiment of the invention for obtaining an impression of buccal teeth parts;

Fig. 8 is an isometric view of a tool in accordance with an embodiment of the invention useful for simultaneously obtaining a negative impression of lingual surfaces of the teeth of both the upper and lower jaws;

Fig. 9 is a simplified block diagram of the sequence of operation in performance of the method in accordance with the invention;

Fig. 10 is an isometric view of a system in accordance with an embodiment of the invention;

Figs. 11 and 12 are, respectively, side and front views of the device shown in Fig. 10; and

Fig. 13 shows a typical block diagram for combining the two-dimensional acquired images to a three-dimensional dental image.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Reference is first being made to Fig. 1 showing a tool 20 in accordance with an embodiment of the invention. Tool 20 has a general shape resembling trays used hitherto in the art for obtaining teeth images. Tool 20 comprises a base 22 which is made of a rigid material such as metal, plastic or the like, which holds a matrix retainer 24 having an outer wall portion 26 and inner wall portion 28 defining between them a trough-like recess 30. Matrix retainer 24 has a general "C"-like shape which approximates the shape of the teeth arrangement in the jaw.

Trough 30 has a shape allowing accommodation of all teeth in a jaw, in their entirety (when trough 30 is fitted over the teeth, the apex thereof will touch or be in close proximity to the bottom 32 of the matrix retainer, and the base of the teeth will be at about at the level of the upper surface of wall portions 26 and 28. The inner walls of recess 28 will typically have a rough or porous surface to allow firm attachment of the impression matrix thereto.

As can also be seen in Fig. 1, base 22 has a rearward expanding, fork-like member 34, and two internally directed projections 36 and 38. Member 34 and projections 36 and 38 are employed to fasten tool 20 within

a slice cutting and image acquisition device, such as that which will be shown below with reference to Figs. 10–12.

In order to obtain a teeth impression, an impression matrix is placed in recess 32, the tool is inserted into the mouth and the teeth are immersed in the impression matrix. As can be seen in Fig. 2, after curing of the impression matrix 40, a plurality of cavities 42, each corresponding to teeth, are fixed in the matrix. Upon curing of the impression matrix, an essentially integral block 44 is formed consisting of matrix retainer 24 and cured impression matrix 40. As can be seen in Fig. 3, when this integral block 44 is viewed from above the contours 46 of the cavities can be clearly seen.

In order to derive the teeth contours from the cured impression matrix, a chosen face of the matrix, which is typically corresponding to the teeth face (although it is possible also to operate from the other face of the matrix) is first levelled to have an upper, essentially flat horizontal surface. An image is acquired, and then consecutive layers are sliced off, after each slicing an image is acquired again. The slicing operation is shown schematically in Fig. 4. Tool 20 with block 44 is placed in a plane and then moved in X–direction, indicated by arrow 46, against blade 48. As will be appreciated, rather than moving tool 20, it is also possible to move blade 48 in the opposite direction. When tool 20 crosses the path of blade 48, the upper surface of tool 20 is leveled. At this stage, a first image can be acquired from the upper face of the block, and then tool 20 is moved upward by a small increment, e.g. 0.15 mm, as represented schematically by arrow 48, and then moved again towards blade 48 whereby a layer is sliced off from the upper surface and another image of deeper layers of the matrix can be acquired, the image at this point corresponding to a level somewhat closer to the teeth apex.

Here again, it can be appreciated that rather than elevating block 20, it is possible also to lower, in similar increments, of blade 48.

Following image acquisition and, straightforward image processing, teeth contours such as those shown in Fig. 5, are obtained, and a plurality of such contours are used to obtain a dental image.

For various applications it is necessary to obtain only a partial dental image, e.g. lingual image or buccal image. This is the case, for example, for a follow-up of orthodontal treatment, where one face of the teeth is covered by braces, and accordingly it is possible to obtain a teeth impression of only the other surface. Furthermore, it is not always necessary to get a complete teeth impression and at times, in order to gain some information on the teeth geometry and the relative teeth position, it is sufficient to obtain an impression of a dental image, of only the lingual and the buccal images.

Reference is now being made to Fig. 6 showing a tool 52 suitable for obtaining a lingual teeth image. Tool 52 has a base 54, which is essentially the same as base 22 of tool 20 (Fig. 1). This tool defers however in matrix retainer 56 which in accordance with this embodiment has two unequal wall portions 58 and 60, external wall portion 58 being lower than internal wall portion 60. In use, impression matrix is placed within trough 62 and then the tool is placed in the mouth so that wall portion 60 presses against the lingual surfaces of the teeth.

Tool 64 shown in Fig. 7, is very similar in principle to tool 52 of Fig. 6 with the difference being that it is intended to obtain an image only of the buccal teeth surfaces. Internal wall portion 66 is higher than internal wall portion 68 and in order to obtain a buccal image, a similar procedure to that used in connection with tool 52 is used here, *mutatis mutandis*.

Reference is now being made to Fig. 8 which illustrates a tool for obtaining a teeth impression 70 having a base 72 with two opposite impression matrix retainers 74 and 76 fixed to the upper and lower faces of the base, respectively. Each of retainers 74 and 76 is essentially the same as retainer 56 of tool 52 shown in Fig. 6. Tool 70 in accordance with this embodiment is useful for obtaining simultaneously dental image of the lingual surfaces of both the upper and the lower jaws. It should be noted, however, that tool 70 is suitable for obtaining such simultaneous teeth impression where the teeth of the upper jaw and those of the lower jaw are essentially overlapping one another, or where there is only a slight shift between these two sets of teeth. In some individuals, there is a considerable distance between the two sets of teeth, and as the artisan can no doubt appreciate, it may at times be necessary to use a matching tool, where the matrix-holding member of the upper and the lower surfaces are shifted one versus the other, to allow simultaneous accommodation of such shifted sets of teeth.

In various orthodontic treatments, the aim is to change the position or orientation of the teeth. A tool such as tool 60 shown in Fig. 6 is particularly suitable to obtain an image of the initial position and to allow a follow-up of the progress of treatment.

Fig. 9 shows a simplified block diagram of a typical manner of carrying out the method of the invention. the upper portion 80 relates to first-time image acquisition; the lower portion 82 relates to a periodical follow-up. Upon first-time image acquisition, e.g. prior to the onset of orthodontal treatment, a full image of the upper jaw 84, of the lower jaw 86 and of the relative positions of the teeth, both rows simultaneously 88, is acquired (the two former images are acquired by the use of a tool such as that shown in Fig. 1; the latter image is acquired by the use of a tool such as that shown in Figs. 6). Each image acquisition follows essentially the

same sequence of operation, and accordingly the entire image acquisition process will be described simultaneously for acquiring of all three images.

Upon obtaining of a negative teeth impression 89 by the use of the appropriate tool, the tool with the impression matrix having a teeth impression is brought into a device which is capable of cutting away thin slices from the matrix and acquiring a teeth impression image. The sequence begins by removing a slice 90 off the upper surface and then acquiring the first image 91. The sequence of slicing of an upper layer from the matrix and acquiring an image is repeated, as represented by block 92, until the entire matrix has been sliced. The individual images which have been acquired during the repeated steps 92, are then digitally processed 94 within a processor to allow for construction of a three–dimensional teeth image 96. The processor then combines the three individual images into one full dental image 98. The dental image thus obtained can then be used to plan the appropriate treatment, design braces for the individual, design bridges, crowns, shape of implants, etc.

Within the framework of follow–up during treatment, it is sufficient to acquire only the lingual surfaces of the teeth. The actual image provides information on the teeth position and orientation, and as the teeth three–dimensional structure does not change, there is no actual need to obtain a complete teeth image. Thus, for follow–up, typically a two–sided teeth impression tool, such as the tool shown in Fig. 6, will be used. The sequence of the image acquisition proceeding will be similar to that described above with respect to first–time image acquisition.

Reference is now being made to Figs. 10–13 showing a system in accordance with an embodiment of the invention, for acquiring a dental image. The system comprises a slicing image acquisition device 100 and a computer 102. Device 100 comprises table 104 having a stage 106 which holds an impression tool 108, which may be a tool such as that shown in

Figs. 1, 6, 7 and 8. Table 104 can reciprocate in a longitudinal (X) direction, represented schematically by means of arrow 110 in Fig. 8, this reciprocating movement being actuated by means of electric motor 112. The entire structure comprising table 104 is held on a table 112. Table 112 is supported on four support members 114, each one of which is rotatable. The rotation of support members 104 is powered by electric step motor 116, which transfers the force to all support members by means of transmission band 118. The rotation of each of support members 114, depending on the direction, will cause either elevation or lowering of table 112.

Device 100 further comprises a rotatable blade 120 powered by spindle motor 122 and comprises a video camera 124 situated above tool 108 when table 104 is in its retracted position as shown in Figs. 10 and 11.

The operation of motors 112, 116 and 122 is controlled by computer 112, which is also linked to video camera 114 and thus receives and can then process image acquired thereby.

After fastening tool 118 on to stage 116, and after optionally filling the impression cavities or recesses with a dye or applying color to the walls of the impression or cavity, a first image may be acquired by camera 124. The table is then pushed forward whereby the upper surface of the block on tool 98 (the block including the matrix and the support member held on the tool) crosses the path of blade 120 and consequently an upper layer thereof is sliced off. Upon retraction of table 114 and bringing it back to the position shown in Figs. 10 and 11, a second image may then be acquired by camera 124. Step motor 116 is then rotated and elevates table 112 by one predetermined step and then the sequence of slicing of an upper layer and acquiring an image is then repeated. The sequence is repeated until the entire block has been sliced off. Then motor 16 lowers table 112 to the initial position whereby the sequence can then be repeated again with a new matrix holding tool.

It should be noted that, rather than changing the relative vertical position of table 104 and blade 120, in a manner as described hereinbefore or in any other manner, it is also possible to stepwise lower blade 110.

Computerized techniques and algorithms for generating the geometry of three-dimensional object from consecutive two-dimensional representations of contours of the object at different latitudes, are generally known *per se*. See for example the following publication which is incorporated herein by reference: "Building, Visualizing, and Computing on Surfaces of Evolution", H. Harlyn Baker, SRI International, July 1988, page 31.

A typical, yet not exclusive algorithm which can be used in accordance with the invention for combining the consecutive contours into a three-dimensional teeth representation is shown in Fig. 12, which is self-explanatory for those skilled in the art in view of the fore-mentioned reference and the available knowledge.

CLAIMS:

1. A method for obtaining a three-dimensional image, comprising:

(a) immersing the teeth, wholly or partially, in an immersion matrix which is *a priori* soft and which is curable within a time period so as to obtain a teeth impression, having a top face corresponding in the directions of the teeth base and a bottom face corresponding to a teeth apex, and having a plurality of cavities or recesses, the boundaries of which correspond to boundaries of the teeth;

(b) removing a layer off a face of choice which is either the upper or the bottom face of the teeth impression so as to obtain a flat, horizontal surface, and acquiring a first elevational, two-dimensional image of the flat surface;

(c) removing a layer off the chosen face so as to obtain a new flat surface and acquire a consecutive elevational two-dimensional image of the new flat surface;

(d) repeating step (c) a plurality of times until removal of all layers of the teeth impression;

(e) determining boundaries of the cavities or recesses in the first image and in each of the consecutive images to obtain a plurality of boundaries representations of the first and subsequent images;

(f) combining all boundaries' representations into a three-dimensional dental image.

2. A method for obtaining a three-dimensional teeth image, comprising:

(a) immersing the teeth, wholly or partially, in an immersion matrix which is *a priori* soft and which is curable within a time period so as to obtain a teeth impression, having a top face corresponding in the directions of the teeth base and a bottom face corresponding to a teeth apex, and

having a plurality of cavities or recesses, the boundaries of which correspond to boundaries of the teeth;

(b) adding a curable plaster to the teeth impression obtained, after curing the plaster, a three–dimensional teeth model;

(c) removing a layer of a face of choice, which is either a face of the model corresponding to the said top face or a face of a model corresponding to said bottom face, so as to obtain a flat, horizontal surface, and acquiring a first elevational, two–dimensional image of the flat surface;

(d) removing a layer of the chosen face so as to obtain a new flat surface and acquiring a consecutive elevational two–dimensional image of a new flat surface;

(e) repeating step (d) a plurality of times until removal of all layers of the teeth impression;

(f) determining boundaries of the teeth in the first image and in each of the consecutive images to obtain a plurality of boundaries representations of the first and subsequent images;

(g) combining all boundaries' representations into a three–dimensional dental image.

3. A method according to Claim 1, comprising either filling the cavities or recesses with a colored dye or coloring the walls of the cavities or recesses with the dye.

4. A method for obtaining a three–dimensional teeth image, comprising:

(a) immersing the teeth, wholly or partially, in an impression matrix which is *a priori* soft and which is curable within a time period so as to obtain a teeth impression, consisting of a plurality of cavities or recesses, the boundaries of the cavities or recesses corresponding to external surfaces of the teeth;

(b) repeatedly removing a thin slice of the teeth impression and acquiring an image of the slice, this sequence being repeated until the entire negative image has been sliced;

(c) combining the plurality of successive two-dimensional images into a three-dimensional dental image.

5. A system for obtaining a three-dimensional teeth image, comprising:

(a) a fastener for holding a matrix comprising either a negative teeth impression or a positive teeth model;

(b) a cutting tool for removing successive thin slices of the matrix;

(c) an imaging device for acquiring successive two-dimensional elevational images of either said matrix or of slices removed therefrom, and digitizing the acquired images;

(d) a processor for combining a plurality of successive digitized acquired images into a three-dimensional dental image.

6. A tool comprising a base; and a matrix retainer fixed on to the base and having a recess for holding an impression matrix, the recess having a general shape allowing immersion of teeth or portions thereof in the impression matrix, to form a negative teeth impression in the matrix, said member being made of a substance which can be cut by a cutting tool capable of cutting the matrix.

7. A tool according to claim 6, wherein the matrix holding member is made of styrofoam.

8. A tool according to Claim 6 or 7, comprising two matrix holding members, fixed at opposite sides of the base

For the Applicants,
DR. REINHOLD COHN AND PARTNERS
By:

98531IC.spc/prg/20.7.95

CADENT LTD.

EIGHT SHEETS
SHEET NO. 1

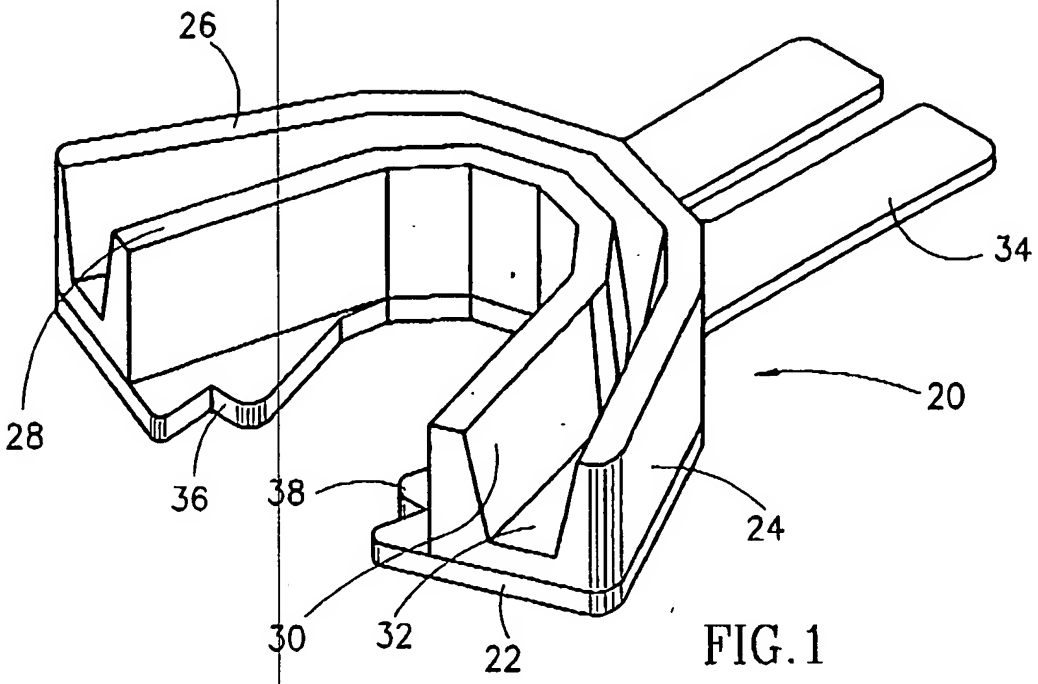

FIG.1

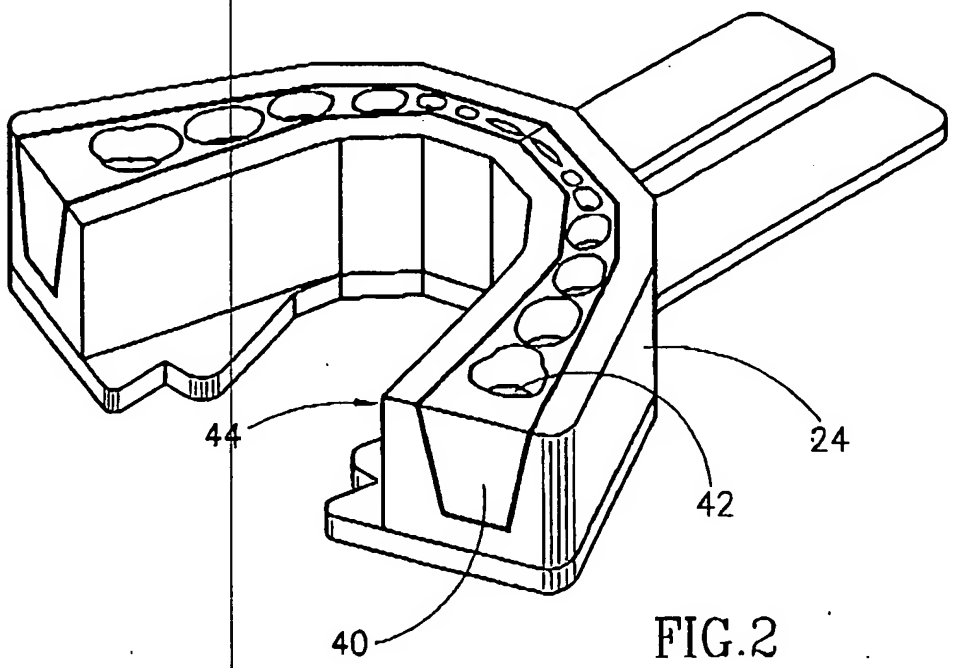

FIG.2

CADENT LTD.

EIGHT SHEETS
SHEET NO. 2

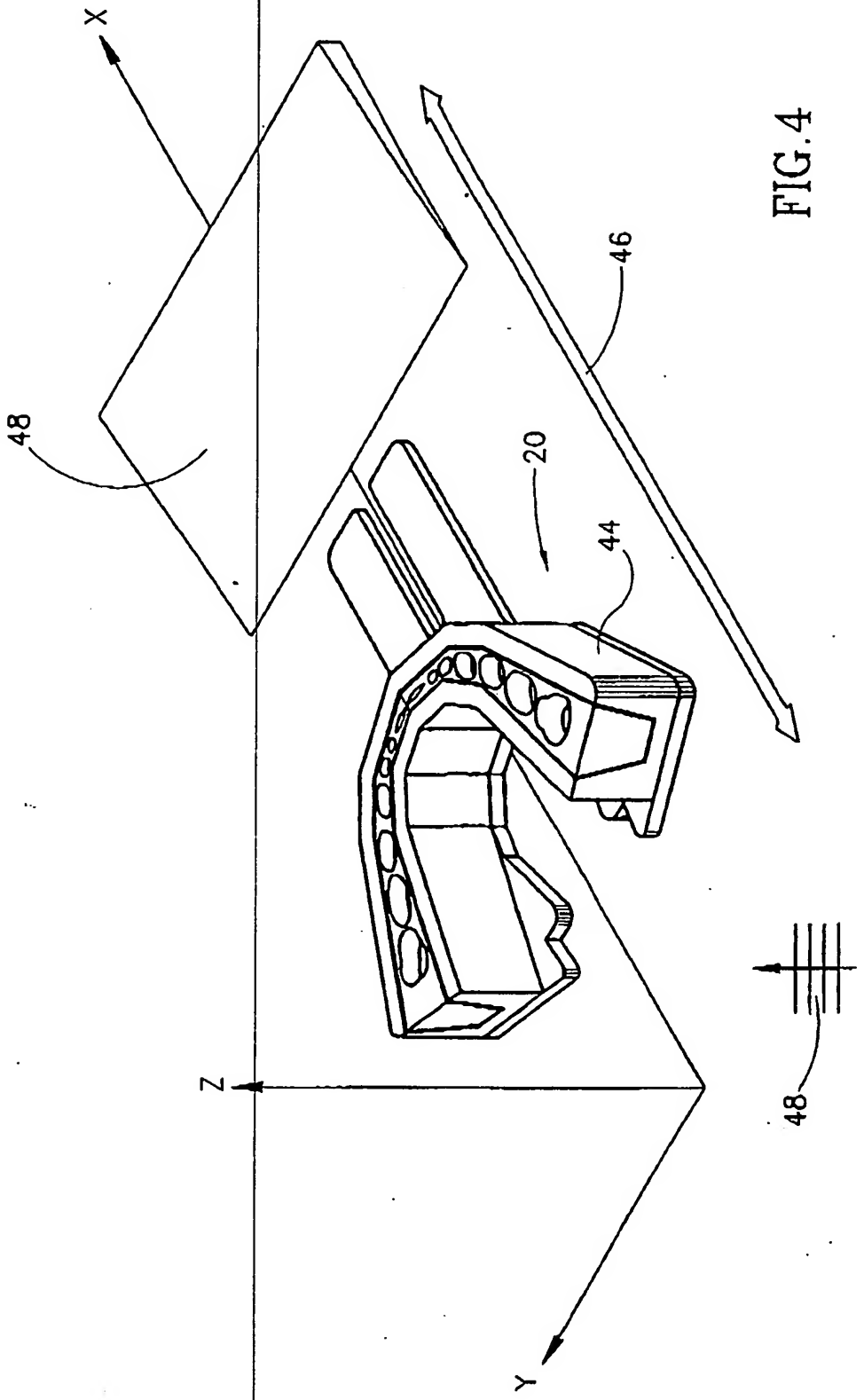

FIG.4

CADENT LTD.

EIGHT SHEETS
SHEET NO. 3

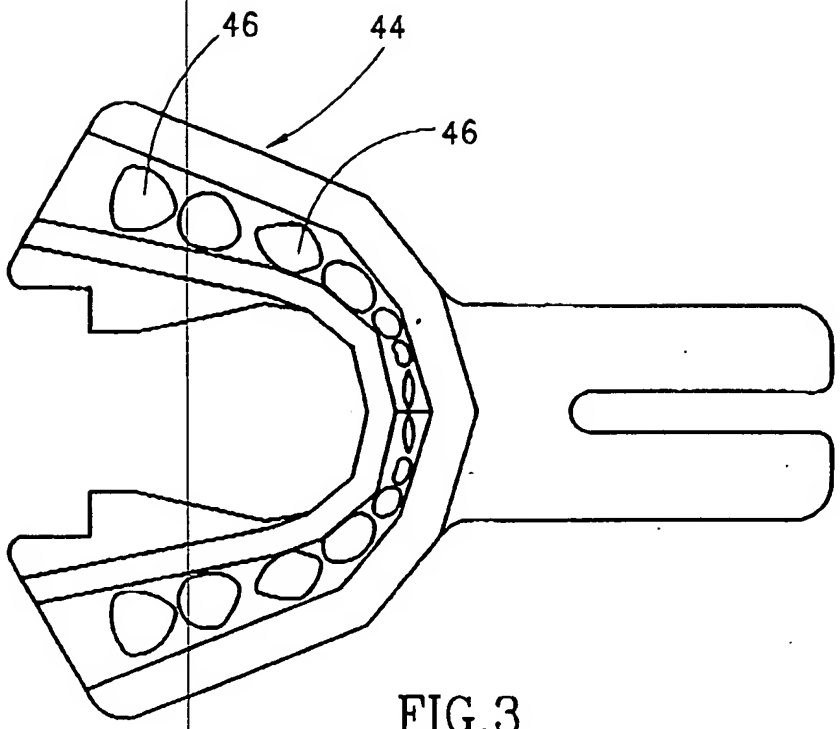

FIG.3

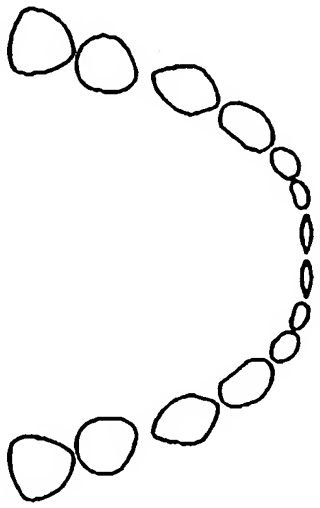

FIG.5

CADENT LTD.

EIGHT SHEETS
SHEET NO. 4

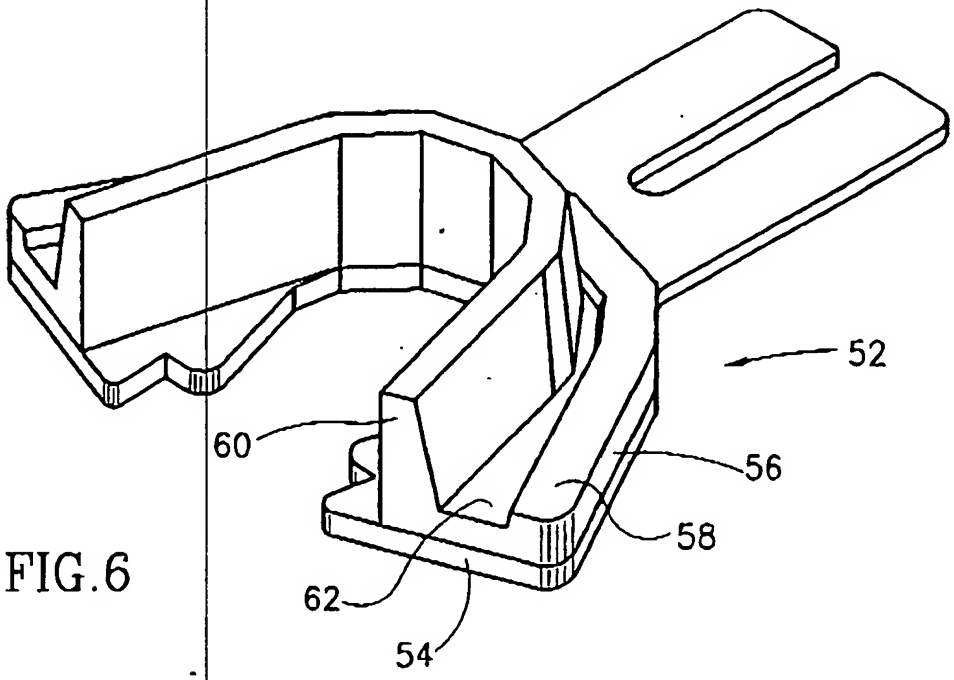

FIG.6

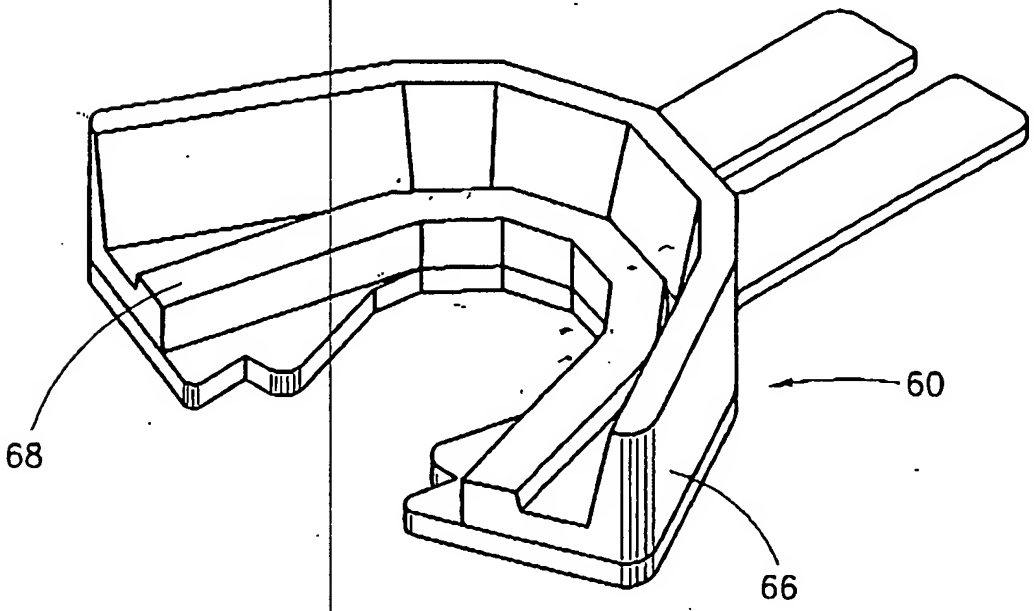

FIG.7

CADENT LTD.

EIGHT SHEETS
SHEET NO. 5.

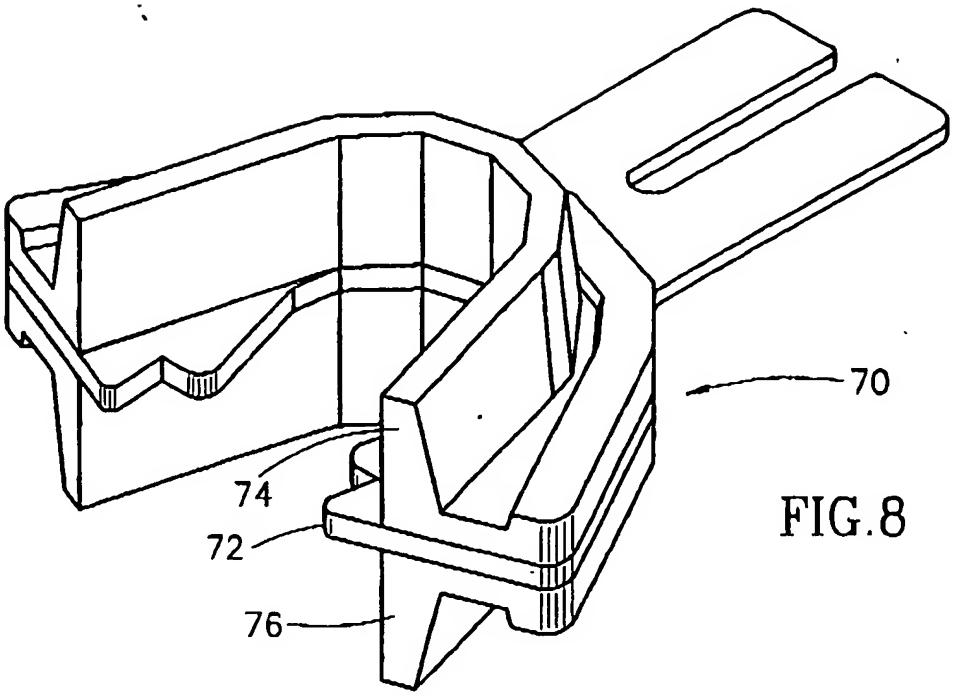

FIG.8

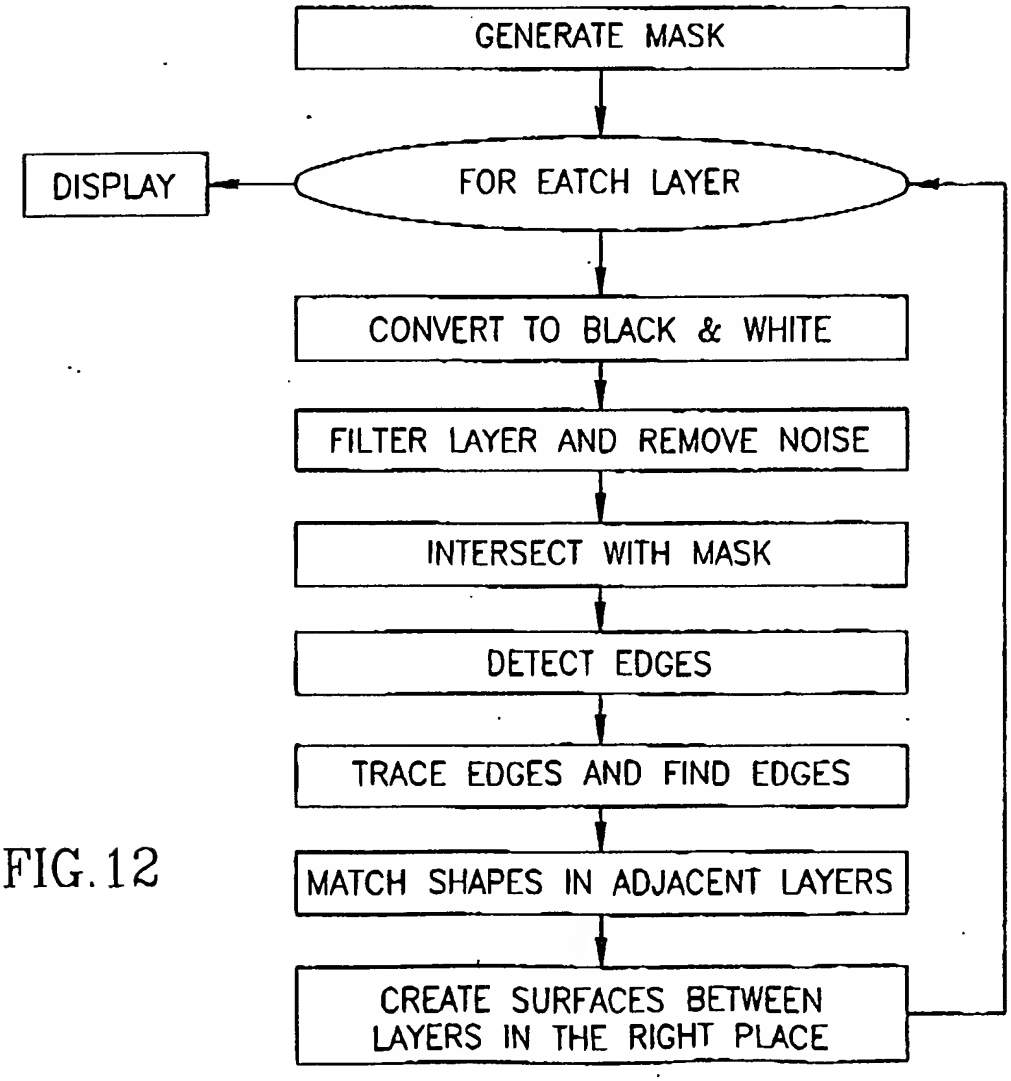

FIG.12

CADENT LTD.

EIGHT SHEETS
SHEET NO. 6

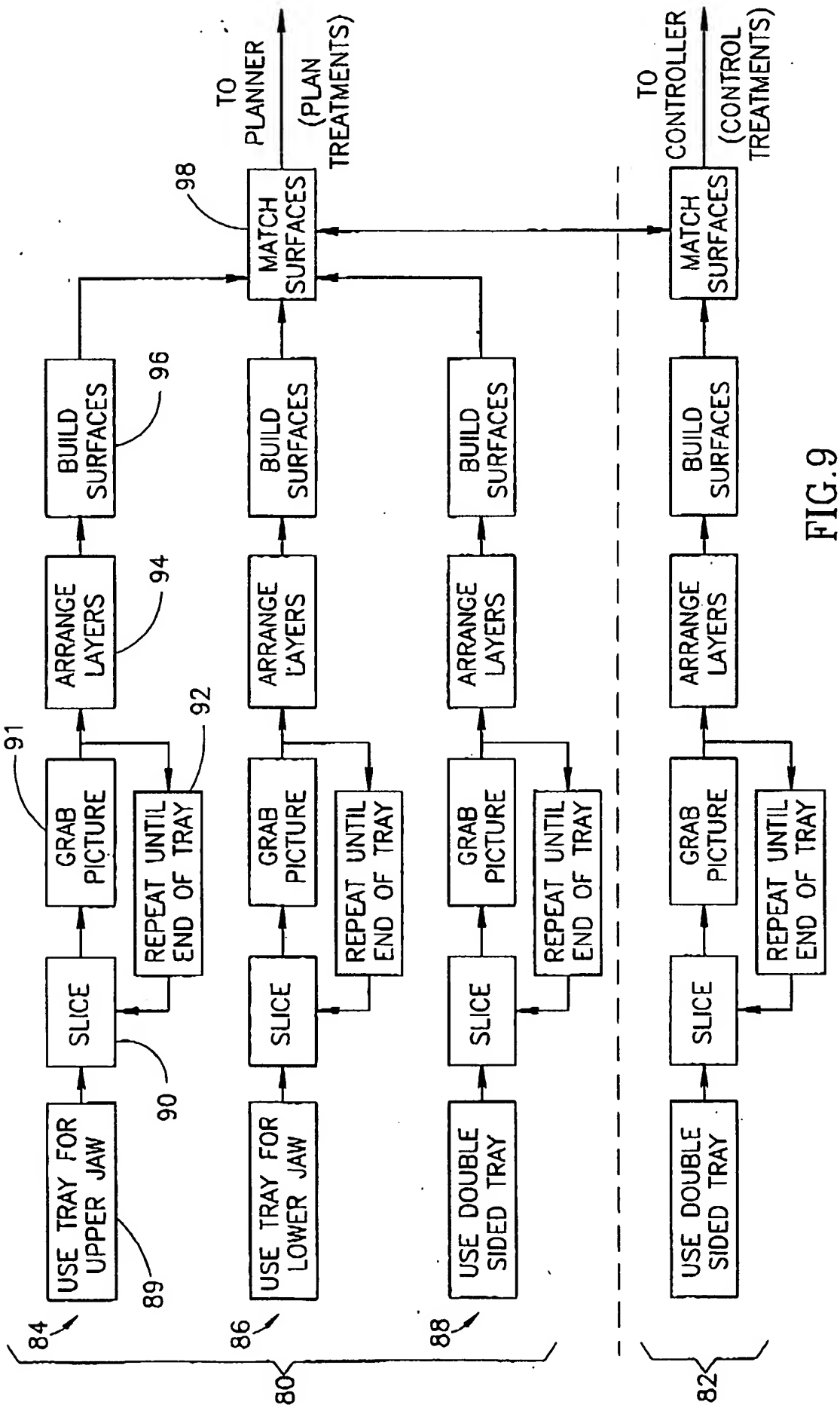

FIG.9

CADENT LTD.

EIGHT SHEETS
SHEET NO. 7

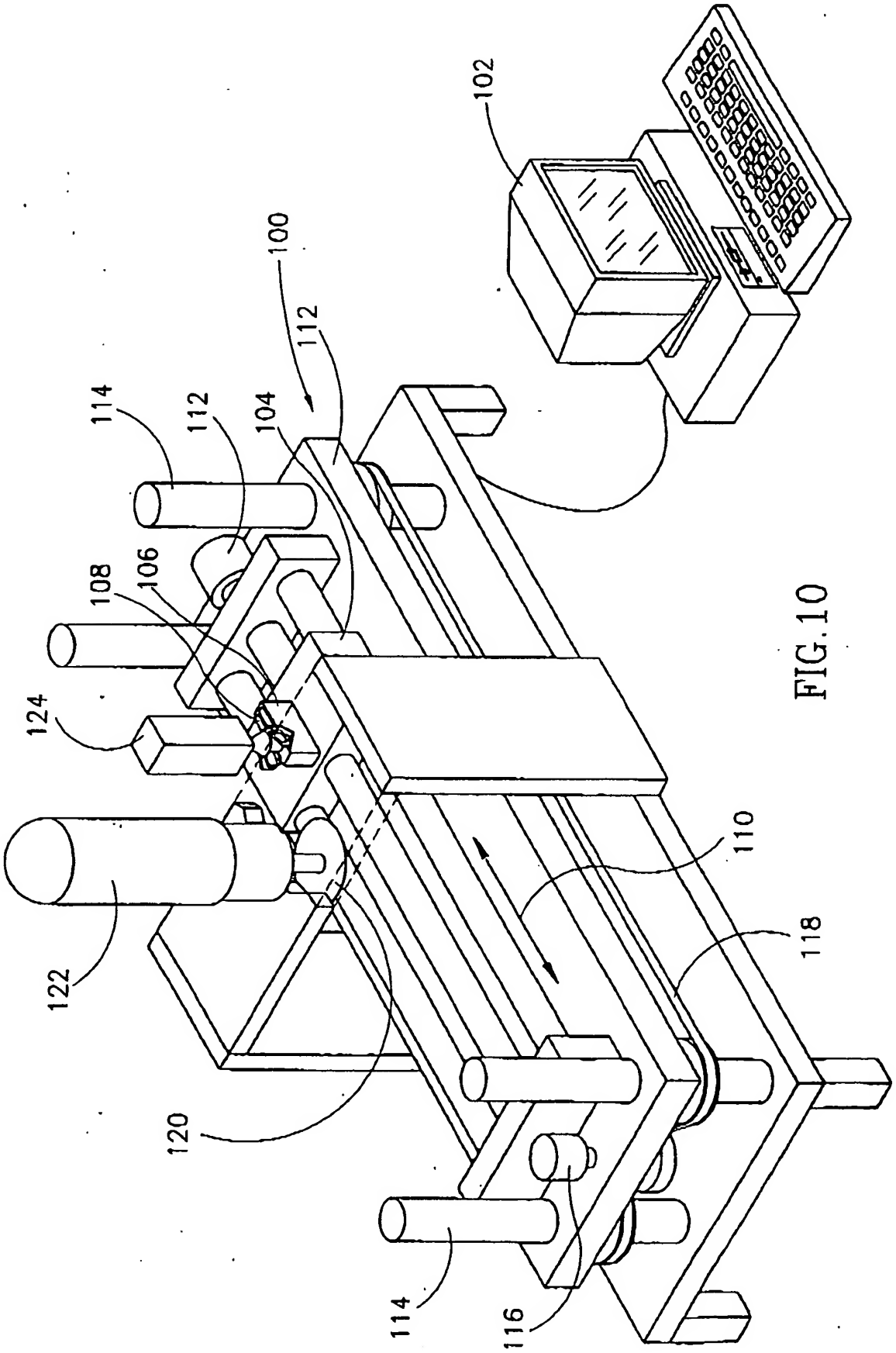

FIG.10

CADENT LTD.

EIGHT SHEETS
SHEET NO. 8

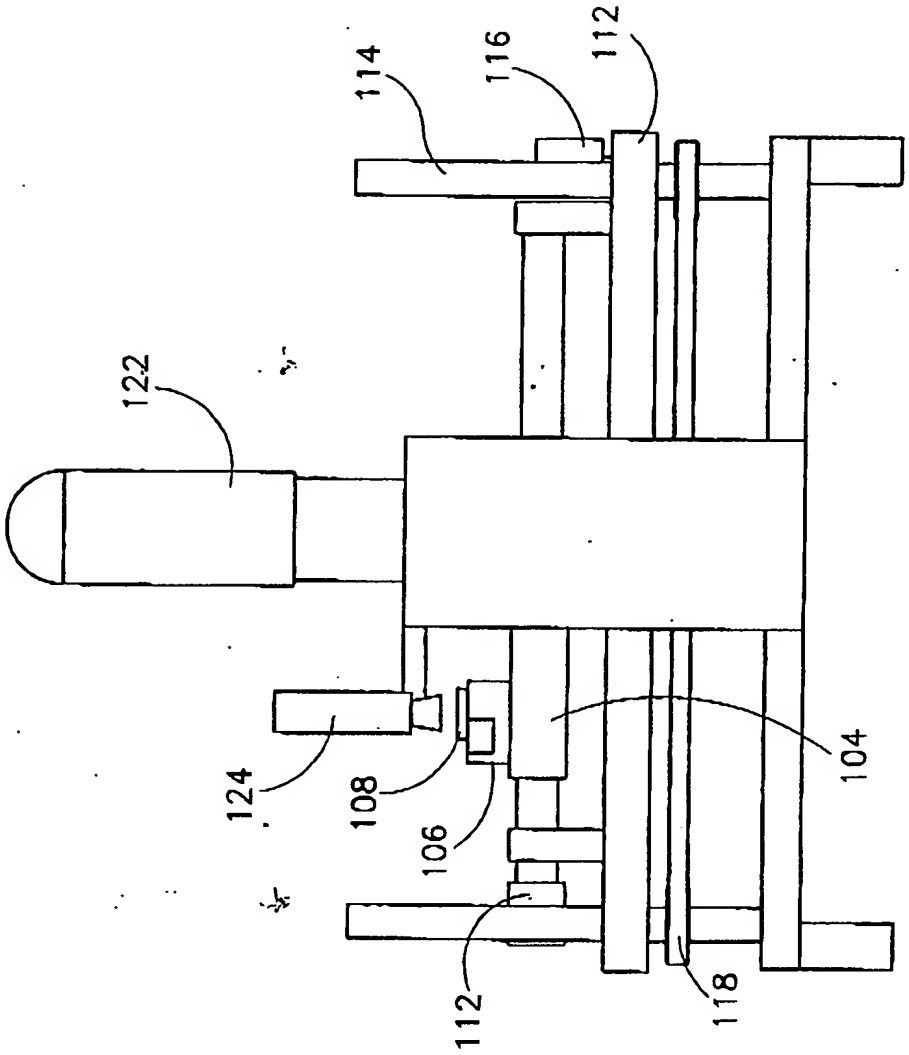

FIG.11

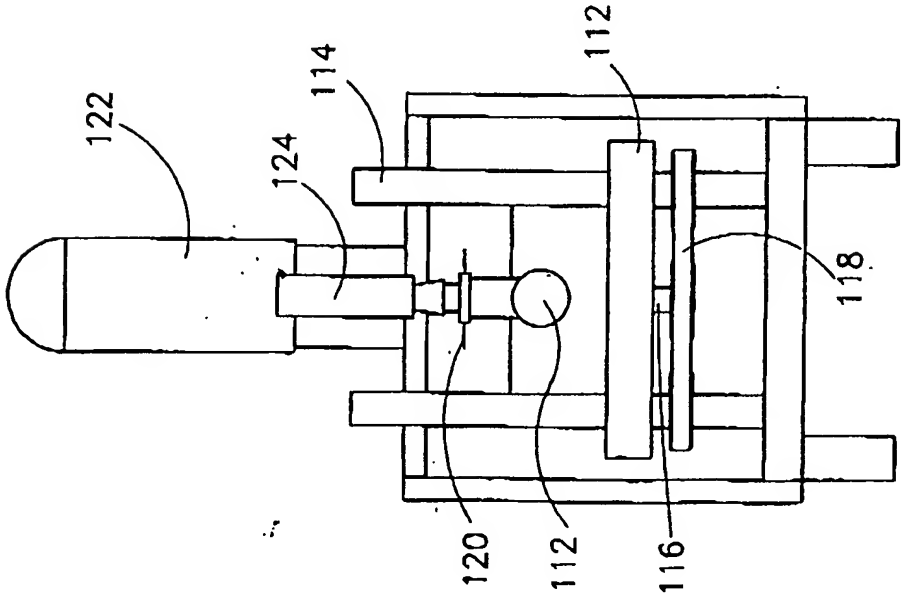

FIG.12